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# Life Cycle of the Banana Weevil, *Cosmopolites sordidus* Germar (*Coleoptera:Curculionidae*) on Plantain (*Musa* AAB group) in Humid Rainforest Agroecology of Southeastern Nigeria.

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## ABSTRACT

The banana weevil *Cosmopolites sordidus* is the most damaging insect pest of plantain, worldwide. A knowledge of its life cycle under the agroecology of the main production areas will provide useful information on management strategies. A study conducted in Uyo, Akwa Ibom State, under ambient temperature and relative humidity of 30 ± 2°C and 80 ± 2%, respectively revealed the following: the developmental period from egg to adult lasted 25 - 38 days and number of larval instars was five. Pre-eclosion period was 6-8 days; 1st larval instar, 2-3 days; 2nd instar, 3-4 days; 3rd instar, 5-6 days; 4th instar, 5-6 days; 5th instar, 6-8 days; pre-pupal period, 1 day and pupal period 6-7 days. The findings conformed to the two empirical laws of growth and development of insects. The mean growth ratio of the head capsule width of *C. sordidus* was 1.38 thus satisfying the acceptable range of 1.3 - 1.4. Furthermore, when the number of instar was plotted against the logarithm of the head capsule width and body length, a straight line graph was obtained. Secondly, the increase by weight of the insect larvae was doubled during each instar and at each moult all their dimension were increased by the ratio 1.26 thus satisfying Dyar's and Przibram's law respectively.

## INTRODUCTION

Plantain (*Musa* AAB) is a major food commodity in sub-Saharan Africa and particularly Nigeria, its highest producer in the world (Ogazi, 1996). A yield loss of up to 40% of the crop of banana attributable to the banana weevil *Cosmopolites sordidus* has been recorded (Gold and Messiaen, 2000). Rukazambuga (1996) reported of a cumulative yield loss of over 52% in the third ratoon crop caused by the insect. According to Tezenas du Montcel (1987), the potential yield of plantain in Nigeria is 50 t $ha^{-1}$, while the actual yield is about 15 t $ha^{-1}$. In the study area, plantain yields are even poorer. Hills (1983) asserted that *C. sordidus* is found wherever plantain is grown in Nigeria, particularly in southern Nigeria. Ortiz *et al.* (1995) reported that ,of the cultivated bananas (*Musa* spp ), plantain is the most susceptible to damage by this insect. One factor responsible for the depressed yields of plantain in Nigeria is the damage caused by this insect.

Successful management of any insect pest requires a knowledge of aspects of its biology, particularly its life cycle. Many studies on the life cycles of insects reveal that they are climatic dependent, and so they vary sometimes slightly and at other times markedly across agroecologies. Information on the life cycle of this insect in the humid rainforest agroecology of Nigeria, the major producing area of plantain is

lacking. However, studies in other agroecologies show marked variation in its life cycle. For example Swaine (1971) reported the maximum life cycle of the insect in Fiji to be about 50 days. Treverrow (1985) asserted that pupal period lasted about 8 days in warm weather. According to him, the period from egg to adult may be as short as 29 days in new South Wales, Australia or as long as six months in the cooler period of the year. The work of Waterhouse and Norris (1987) showed that egg incubation took eight days in summer in West Indies. Bakyalire (1992) observed that the life cycle is 60-80 days in East African highland. Ngeze (1994) said the larvae mature after about 20 days post-eclosion in Tanzania while Pavis and Lemaire (1996) claimed that length of life cycle varied according to environmental conditions but lasted an average of two months. Results of study by Kiggundu (2000) showed that in the tropics whole life cycle lasts 40 - 70 days.

This study conducted in Uyo, Akwa Ibom State Nigeria, a major plantain producing area is to determine the life cycle of *C. sordidus* on plantain, its most susceptible host, with a view to providing useful information to assist in management strategies for improved yields in the area.

## MATERIALS AND METHODS

Five mated females were introduced to clean pieces of corm tissues each weighing about 500g for oviposition for three days. in plastic containers( of 0.5 litre volume), with perforated covers lined with fine cotton mesh. in plastic containers with perforated covers lined with fine cotton mesh. Eggs deposited were marked for observation. The corm tissues were incubated in the laboratory (at the temperature of 28±2°C and relative humidity of 80±2% ) The containers were left to float on water in big basins which surface tension was reduced with detergent solution. This was to prevent invasion by ants and other egg/larvalpurpal parasites/ predators. Marked eggs were monitored daily until hatching. On hatching, larvae were excavated and measured with the aid of a microscope fitted with micrometer. Head capsule, body length, body width and body weight were some parameters monitored. Slits were cut in clean fresh corm tissues and extracted larvae inserted. The growth and development of the larvae were monitored every two days by dissecting, taking measurements as described above and transferring to new corm pieces until the insects pupated. Corm pieces with pupal cocoons were kept moist by placing them on moistened tissue paper regularly and observed daily until emergence of adult.

In a corroborative experiment, the corms of plantain suckers were pared to ensure they were clean (uninfested) and the pseudostem cut 20cm above the collar. These were planted nine in concrete pots each measuring 70cm x 60cm x 60cm, two-third filled with sterilised soil, and placed outside the laboratory. One hundred pairs of field-collected weevils using the split-pseudostem technique as reported by Sweenen (1990) were released into each pot and watered thereafter. The tops of the pots were covered with fine cotton mesh and the mesh kept in place by placing concrete blocks on the edges of the pots. The weevils were allowed to oviposit for four days after which the suckers were transplanted to new pots and covered with cotton mesh after a thorough check to ensure that such suckers carried no adult weevil. With effect from 4 days after planting and every two days thereafter, one sucker each was uprooted and carefully dissected to monitor the growth and development of the various developmental stages of the weevils in situ..

Larval instars were monitored by measuring body length, body width, body weight and width of head capsule. In the main experiment, twenty members of each instar were measured and the mean obtained. In the corroborative experiment, since sample number was far smaller, raw values obtained for each of the growth parameters were merely observed to see if they differed from any of the twenty samples from the main experiment in which the means were computed. The measurements were taken to see how they conformed to Dyar's and Przibram's rules, two empirical laws used to determine number of moults in insect species. Przibram's rule cited by Wigglesworth (1965) stated that the body weight of the insect larva is doubled during each instar and at each moult all linear dimensions are increased by the ratio 1.26.

## RESULTS

The ambient temperature and relative humidity of the laboratory in which the study was conducted was 28 ± 2°C and 80 ± 2% respectively. The fecundity of the female insect was low. Eggs were laid singly on the corm tissue. Male insects were smaller in size than the females. The insect underwent a complex or complete metamorphosis as is common with the coleopterans. Figure 1 shows a presentation of the life cycle of the insect as captured during the study; table 1 shows the physical dimensions (body length, body width, body weight and head capsule width) of the larval instars; table 2 shows the mean duration of the developmental periods. Only data obtained form the main experiment is presented. This is because every value obtained for each growth parameter in the corroborative experiment tallied with at least three of the 20 samples which mean value was used in the main experiment. This showed that the results from both the main and corroborative experiments were in conformity

Mature males mounted on the back of mature females (Fig 1b); the male later clasped the female strongly with its curved last abdominal tergite. The female laid eggs which appeared white in colour but turned light yellow or brown after about 24 hours (Fig 1c). The eggs hatched into the opodous larvae with brown head capsule after a pre-eclosion period which ranged between six and eight days. The first larval instar (Fig 1d) which looked colourless and cylindrical with transparent body bored into the plantain tissue on which the egg was laid. The larva had mean length of 3.95±0.450 mm, mean body width of 1.16±0.167 mm, mean weight of 0.007±0.0018 g and mean head capsule width of 0.825±0.118 mm (Table 1). This stage lasted for 2 to 3 days (Table 2). The measurement of subsequent physical dimensions of the developing larvae showed a total of five larval instars. The second larval instar (Fig 1e) also lasted about 2 to 3 days and showed a gradual increase in all parameters of growth over the first instar This second instar was also cylindrical in shape. However, the third and subsequent instars had bulged and curved abdomen and body width measurement were taken at the widest points. The third and fourth instars (Figs 1f and 1g) were whitish to creamy white in colour and each lasted about 3 to 4 days with mean lengths of 8.60±0.221 mm and 11.00±0.023 mm, widths of 2.84±0.075 mm and 3.68±0.112 mm, weights of 0.044±0.0025 g and 0.091±0.0038 g and head capsule widths of 1.625±0.125 mm and 2.237±0.082mm, respectively. The hairs on its body were more apparent at this stage. The fifth larval instar (Fig 1h) lasted about 6 to 8 days and the colour was light yellow. Other physical features were mean length of 14±0.044 mm, mean width of 4.98±0.149 mm, mean weight of 0.183±0.0080 g and mean head capsule width of 3.067±0.052 mm.

*Table 1:* Mean larval length, width, weight and head capsule width ± SE of five larval instars of *C. sordidus* in Akwa Ibom State, Southeastern Nigeria (n = 20)

| Instar | Mean larval length (mm) | Mean larval width (mm) * | Mean larval weight (g) | Mean head capsule width (mm) |
|---|---|---|---|---|
| 1st | 3.95 ± 0.450 | 1.16 ± 0.167 | 0.007 ± 0.0018 | 0.825 ± 0.118 |
| 2nd | 6.41 ± 0.026 | 2.05 ± 0.198 | 0.021 ± 0.0017 | 1.133 ± 0.120 |
| 3rd | 8.60 ± 0.221 | 2.84 ± 0.075 | 0.044 ± 0.0025 | 1.625 ± 0.125 |
| 4th | 11.00 ± 0.023 | 3.68 ± 0.112 | 0.091 ± 0.0038 | 2.237 ± 0.082 |
| 5th | 14 .00± 0.044 | 4.98 ± 0.149 | 0.183 ± 0.0080 | 3.067 ± 0.052 |

*Table 2:* Range of duration and mean duration ±SE of the developmental stages in the life cycle of *C. sordidus* in Akwa Ibom State, Southeastern Nigeria

| Developmental stages | Range of Duration (days) | Mean Duration ±SE (days) |
|---|---|---|
| Pre-eclosion | 6-8 | 7.14 ± 0.34 |
| 1st larval instar | 2-3 | 2.80 ± 0.19 |
| 2nd larval instar | 2-3 | 3.00 ± 0.31 |
| 3rd larval instar | 3-4 | 3.70 ± 0.18 |
| 4th larval instar | 3-4 | 4.00 ± 0.31 |
| 5th larval instar | 6-8 | 6.70 ± 0.18 |
| Pre-pupal | 1 | 1 |
| Pupal | 6-7 | 7.40 ± 0.20 |
| **Total** | **29-38** | **35.74± 1.71** |

Damage to the corm tissues by the larvae appeared proportional to the advancement in age. The third to the fifth instars were particularly active an destructive. The last (5th) instar appeared to feed more towards the periphery of the

corm, became motionless and spinned a cocoon or oval chamber around itself to form the pupa (Fig i). The pre-pupal stage lasted about 24 hours. The larval body shrunk in size, turned brighter yellow and formed buds to separate the thoracic region from the abdomen. During this stage, the insect stopped tunnelling and used its strong mandibles to tear corm fibres into threads fortified with frass to wind round itself. It exuded slimy secretions which it used to smoothen the chamber by spasmic movements of the abdomen. The cast skin (exuviae) of the pupal moult into adult was very obvious in all the broken cocoons examined. The cast skin was found at one end of the pupal chamber. The length of the pupae ranged between 8mm and 11mm with a width of about 4mm. It was exarate in form and white to milky white in colour. The pupal form lasted 6 to 7 days and metamorphosed into a newly emerged adult (Fig j) which was light brown in colour at emergence and gradually turned black thereafter. It remained and fed inside the corm tissue for few days before exiting. Figure 2 shows straight line graphs obtained by plotting the number of instars against the logarithm of the larval lengths and head capsule widths of the insect

## DISCUSSION

The random observations made on some aspects of the biology of *C. sordidus* in this study agrees substantially with the findings of workers in other geographical locations such as Jones (1986), Waterhouse and Norris (1987), Swennen (1990), Ngeze (1994). However, the life cycle varied largely from those of some workers on the one hand and is in consonance with the findings of some others. Bakyalire (1992), for example, reported that the life cycle of the weevil was 60 - 80 days in east African highland. Swaine (1971) had reported of the maximum lifecycle of the insect to be about 50 days in Fiji, while Treverrow (1985) reported of a period as long as 6 months in the cooler period of the year in south Wales Australia. Pavis and Lemaire (1996) observed that the lifecycle lasted an average of 2 months but varies according to environmental conditions. Kiggundu's (2000) finding was that the whole lifecycle lasted 40-70 days in the tropics.

The finding in this study is that the lifecycle lasted 33.5 days in Uyo, Akwa Ibom State, South eastern Nigeria at $28\pm2^{\circ}C$ and $80\pm2\%$ relative humidity. This is in harmony with the findings of Treverrow (1985) under warm weather in south Wales, Australia, but differs substantially form what he obtained in the cooler period of the year. Egg incubation period of 8 days in summer in West Indies (Waterhouse and Norris, 1987) is also in conformity to our findings. Gold and Messiaen (2000) reported that under tropical conditions, the egg to adult period is 5-7 weeks. This is in agreement with our findings.

The physical measurements of the weevil obtained in this study showed that the larvae passed through 5 instars. Gold and Messiaen (2000) reported of 5-8 instars but added that developmental rates are temperature dependent. Okoronkwo *et al.* (1996) cited Metcalf *et al.*(1962) who asserted that the number of moults in instars was not always constant and might be influenced by environmental temperature. this probably accounted for the higher number of instars as reported by Gold and Messiaen (2000).

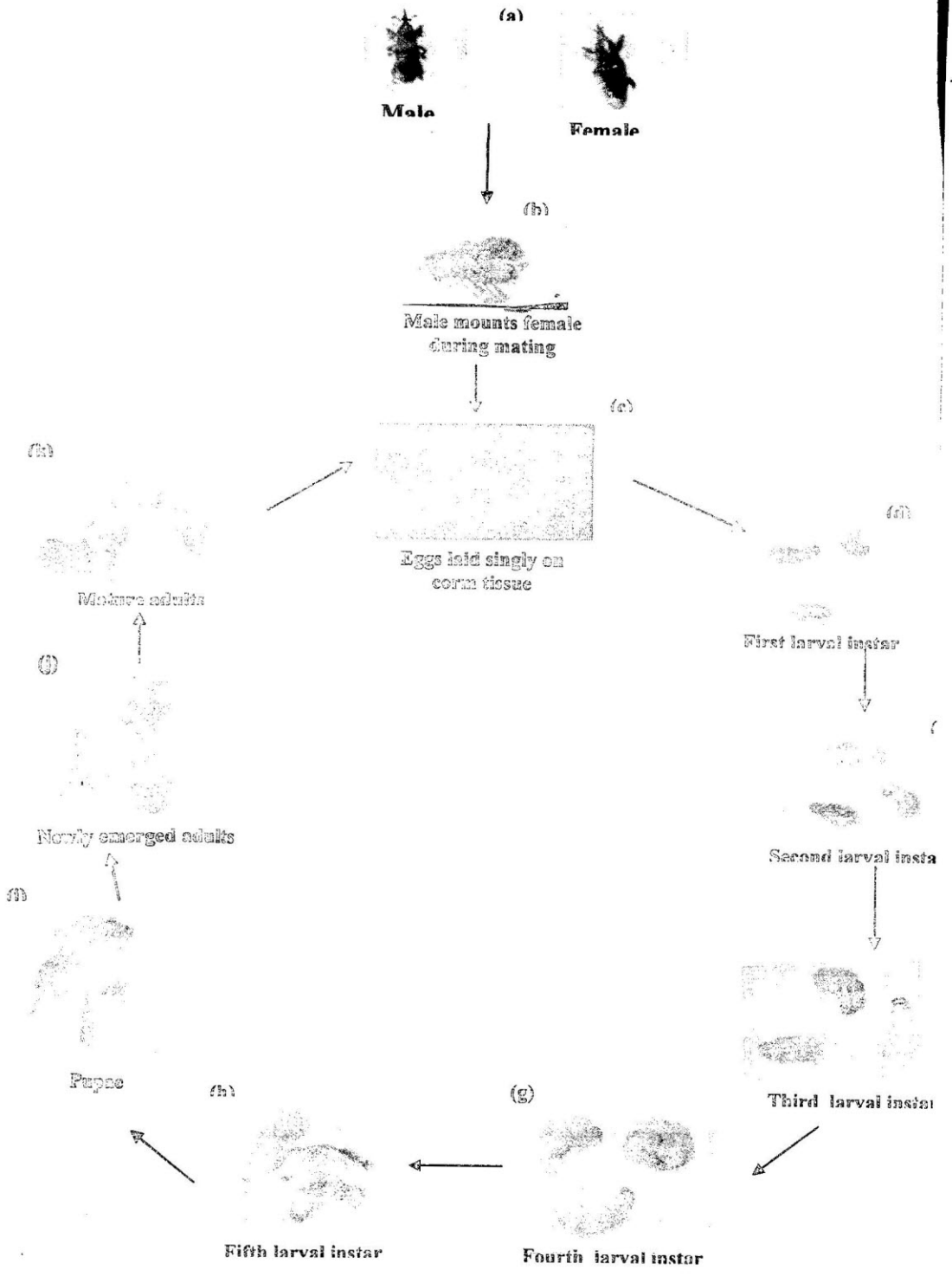


***Fig. 1:*** Lifecycle of the banana weevil *C. sordidus* Germar on plantain in Uyo, Akwa Ibom State, Nigeria.

Patton (1963) had indicated that physical measurements of a part or ratio of measurement of two parts could be related to development in many insect species. Dyar (1890) cited by Imms (1925) and Borror and Delong (1970) had shown that the head capsules of some insect larvae grow in geometrical progression increasing in width at each moult by a ratio constant for a given species. According to the report the acceptable range for this ratio is 1.2 –1.4. in this study the mean growth ratio of the head capsule width of *C. sordidus* was 1.38. This satisfies Dyar's rule. Furthermore, when the number of the instars were plotted against the logarithm of some measurements on the insect, a straight line is generally obtained.The mean growth ratio of the head capsule width of *C. sordidus* as measured in this study was 1.38. This satisfies Dyar's rule. Furthermore, when the number of the instar is plotted against the logarithm of the head capsule widths and body lengths obtained at each instar of the insect, a straight line was obtained as seen in Fig. 2. Another empirical law of growth, Przibram's rule, cited by Wigglesworth (1965) states that the body weight of the insect larvae is doubled during each instar, and at each moult, all linear dimensions are increased by the ratio 1.26. the result of this study also conforms to this law.

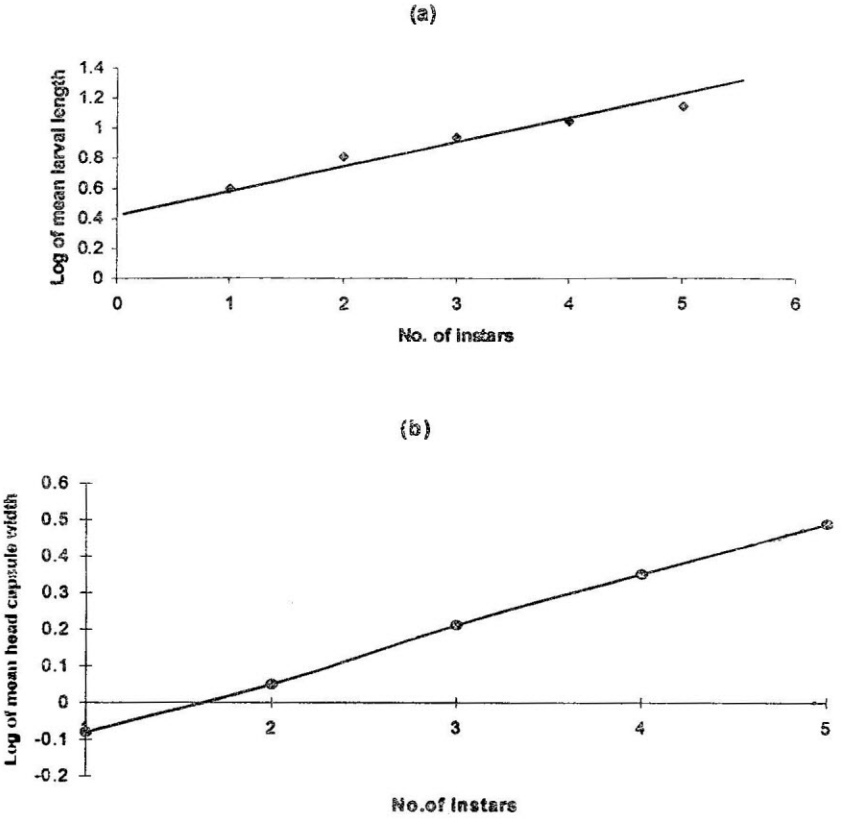


Fig. 2: Straight line curves obtained by plotting number of instars of the banana against the logarithm of the insect (a) larval length and (b) head capsule

## CONCLUSION

In view of the wide variations in the developmental stages of the banana weevil across climatic and agroecological boundaries, the findings in this study will be of particular benefit to any management programme against this insect in the rain forest agroecology of Nigeria, the larges plantain producing country in the world.

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